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SHELL MOUND FORMATION IN NORTHERN AUSTRALIA: A CASE STUDY FROM CROKER ISLAND, NORTHWESTERN ARNHEM LAND.

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ABSTRACT

A controversy has recently arisen over whether the shell and earth mounds identified by archaeologists in northern Australia were constructed by the megapode, *Megapodius reinwardt*. Criteria for distinguishing human shell mounds and megapode mounds are advocated. These criteria are applied to a recently excavated shell mound from Croker Island, northwestern Arnhem Land.

KEYWORDS: shell mounds, northern Australia, *Megapodius reinwardt*, Croker Island.

INTRODUCTION

Many large mounds of shell and earth have been recorded by archaeologists on the coast and floodplains of northern Australia (e.g. Bailey 1975, 1977, 1983; Beaton 1985; Cribb 1986; Cribb *et al.* 1988; Meehan 1988, 1991; Mulvaney 1975, 1981; Peterson 1973; Tacon 1989). Archaeologists have argued that these mounds were formed by humans, whether through repeated occupation or deliberate construction. Ethnographic observations across northern Australia have also made it clear that humans lived upon, and at least contributed to, the formation of shell and earth mounds (Meehan 1991; Peterson 1973; Roth 1984).

Recently, however, a controversy has arisen over the origin of these features. Stone (1989,1991a) proposed that the large earth and shell mounds of northern Australia were not constructed by Aboriginals, but by generations of nesting Orange-footed Scrubfowls (*Megapodius reinwardt*). His argument, not surprisingly, has drawn criticism from a number of archaeologists concerned with northern Australian shell mounds (Bailey 1991; Cribb 1991; Roberts 1991). The purpose of this paper is to determine criteria by which shell mounds formed by humans may be distinguished from mounds constructed by scrubfowls. These criteria are applied to a recently excavated shell mound from Croker Island, in northwestern Arnhem Land. The case study serves to demonstrate the applicability of the criteria to archaeological evidence.

Stone (1989) raised three points to support his argument regarding mound origins:

1. There are broad similarities in the distribution of mounds recorded by archaeologists, and the distribution of the Orange- footed Scrubfowl. Both the scrubfowl and archaeologically recorded mounds are found in similar latitudes, (although Stone's (1989:63) map of scrubfowl distribution is not particularly precise). Stone (1989:60) also argues that archaeologically recorded mounds tend to occur in the same environments as scrubfowl nests; along the edges of tidal rivers, beaches, mangrove swamps and freshwater wetlands.

2. The naturalist, John Gilbert, visited Port Essington in 1840 and conducted research into megapode nesting behaviour (in Gould 1865:167-174). Although the local European residents of Victoria settlement believed the earth and shell mounds in the area were built by Aboriginals, the latter told Gilbert that the mounds were scrubfowl nests. After being shown mounds by Aboriginals that contained chicks and buried eggs, Gilbert became convinced these features were birds' nests.

3. Stone (1989) also pointed to the lack of Aboriginal mythology about construction of the

mounds. He referred to a statement of a senior Yirritja man from Galliwinku, who is reported to have said that the Millingimbi shell mounds were made by scrubfowls.

Stone was quite general in his overall approach. No attempt was made to consider observations on the nesting behaviour of the bird in order to identify criteria by which natural and human mounds may be differentiated. This weakness is reflected within Stone's argument regarding the size of scrubfowl mounds. He argued that the large shell and earth mounds of northern Australia are scrubfowl nests, while smaller, low lying mounds may be undisturbed Aboriginal shell middens. No indication of the threshold between the two types of mounds was provided.

Stone conceded that despite their avian origins, shell and earth mounds may contain artefacts, artefactual shell and even human skeletal material. This material can be incorporated into the mound in one of two ways. Cultural material may have been raked up by scrubfowls from material left behind by Aboriginals on the soil surface around the mound. Alternatively, Aboriginals may have occasionally camped on the top of these scrubfowl mounds, and deposited cultural material. Stone (1989:61) argued that such occupation would have contributed relatively little material to the mound, and that these features must still be seen as scrubfowl constructions.

Stone's argument has drawn a spirited defence from Bailey (1991) and Cribb (1991), who argued the large shell mounds near Weipa and Aurukun respectively are human in origin. The principal argument of both archaeologists was the environmental context of the mounds, with the largest of them being found on the margins of mangroves and saltpans. Such locations are ideal for human exploitation of shellfish, but are totally unsuitable for scrubfowl nesting. Cribb (1991) also draws on arguments concerning the structure and composition of the Aurukun shell mounds. Stone (1991b) responded principally by suggesting that Bailey and Cribb had not considered evidence for palaeoenvironmental change closely enough.

As Bailey (1991:22) noted, one thing that has been lacking from the debate is objective criteria, applicable to field evidence, to discriminate between scrubfowl and human mounds. Analysis of eyewitness accounts of bird mound construction and use could allow us to determine criteria by which human shell mounds may be distinguished from bird mounds. Accordingly, observations on megapode nesting behaviour are reviewed in the next section. The characteristics of scrubfowl mounds are compared to those of shell mounds recorded archaeologically. Note that only shell mounds are considered. Earth mounds composed mostly of sediment and attributed to human construction (e.g. Meehan 1988, 1991; Peterson 1973), are excluded from the discussion. This distinction has been drawn because it is likely that different formation processes led to the construction of earth and shell mounds.

NESTING BEHAVIOUR OF THE SCRUBFOWL AND CRITERIA FOR THE RECOGNITION OF HUMAN SHELL MOUNDS

Megapodes exploit external sources of heat to incubate their eggs. These sources include solar radiation, geothermal activity and organic decomposition (Frith 1956). The scrubfowl *M. reinwardt* constructs large mounds in order to incubate its eggs, scraping up building material by kicking it backwards with its foot (Crome and Brown 1979). Mounds may be constructed from a range of materials including vegetable material, soil, gravel, sand and shell (Table 1). The mounds are important to the bird because of their ability to generate heat for the incubation of eggs. According to Jones (1989:148) "...by concentrating suitable material (moist leaf litter)...and sustaining favourable conditions (mixing of fresh mound materials), heat results from the respiration of microorganisms in the mound, principally thermophillic fungi...".

Once the temperature in the mound is correct, the bird digs a series of diagonal burrows, as much as two metres deep (MacDonald 1973:120). A single egg is deposited at the bottom of each burrow, and the holes are filled up (Crome and Brown 1979). A nesting pair usually lays 12-15 eggs during the breeding season (Cayley 1987:101). Chicks hatch after six weeks, and tunnel out of the mounds. More than one pair of birds may use and build a mound at once, and an active mound is enlarged each breeding season (Cayley 1991:41; Crome and Brown 1979).

Observations on the shape, size, composition and environmental context of scrubfowl mounds are summarized in Table 1. Despite being made by different observers in a variety of areas, the observations form a reasonably consistent set of data. This data set can serve as a basis for

Table 1. Observations on scrub fowl mounds and mounding behaviour.

Reference	Location of observation	Mound shape	Mound size	Mound composition	Environmental context
Stokes (1846:395-396)	Port Essington	-	30ft long and 5ft high.	-	Always built near thick bushes.
Gilbert (in Gould 1865)	Port Essington	1. Irregular in outline resembling a ridge or bank thrown up by heavy surf.	20-39ft long and 5ft high.	Mostly sand and shells sometimes with soil and decayed wood.	Dense thickets immediately adjacent to sea.
		2. Conical	From 20ft in circumference and 5ft high to 60ft circum ference and 15ft high.	Light black vegetable soil.	Dense thickets near creeks.
MacGillivray (in Gould 1865)	Endeavour Straits	Conical, or an irregular oval with a flattened summit.	From 77ft circumference and 8ft in height to 150ft circ. and 14ft in height.	Earth, stones and decaying vegetable matter.	Jungle
Napier (1876:50-52)	Castlereagh Bay	Dome shaped with a hollow on top of 5ft diameter.	15ft high and 56ft circumference.	Earth.	200m from heach.
Searcy (1909:71)	Arnhem Land	Resembles a small hill.	60-160ft circumference.	Loose, sandy soil	-
MacGillivray (1914:135-136)	Cape York Peninsula	Flattend at the top	Up to 15ft. high and 30 ft. diameter at the base.	-	Scrubs.
Mathews and Iredale (1921:219)	-	Rotund, occasionally conical	20ft diameter at base, and 5ft high.	Loose, black vegetable mould or soil, mixed with sticks and leaves. Chiefly sand and shells if near the beach.	Usually within a few hundred yards of seashore within thickly foliaged forest.
Barrett (1941:108)	Wessel Islands	-	6ft to 15ft high and up to 150ft in circumference.	Sandy soil and leaf litter mixed with sticks and twigs.	-
Frith (1956)	Darwin	Usually conical, sometimes forms a long, narrow ridge	Conical forms up to 35ft diameter and 15ft height. Ridges are up to 10ft high and 60ft long.	Earth and leaf mould or sand and seaweed depending on distance to sea.	-
MacDonald (1974:129-130)	-	-	Average 3m across and 1.5m high, can reach 15m across and 4m high.	Inorganic material topped with rotting vegetable mould.	Dense thickets along coasts or waterways.
Frith and Hitchcock (1974:129-130)	Cobourg Peninsula	-	-	In forests vegetahle matter and soil. In exposed situations sand shells with little organic material	Monsoon forests or dense growth near water.
Crome and Brown (1979)	Cape York Peninsula	-	Subsidiary mounds 0.7m high and 2m in diameter.	Mounds near beaches have a high proportion of sand mixed with leaf litter. If in land mostly of leaf litter with a small amount of soil.	Monsoon vine forest
Beruldson (1980)	-	-	Huge	Decaying vegetahle matter and sand when available.	Thick forests, sometimes mangroves.
Pizzey (1987:90)	-	-	Up to 12m in diameter and 5m high but usually much smaller.	Earth and vegetation or sand.	Rainforest and scrubs, occasionally mangroves.
Cayley (1991:41)	-	Conical	Up to 10-12m across and several metres high.	Earth and leaf mould or sand and seaweed.	Dense scrub sheltered by large trees.

identifying criteria useful in distinguishing scrubfowl mounds from human shell mounds.

Mound size. Observers listed in Table 1 recorded scrubfowl mounds as high as 5 m (17ft) and with a circumference at the base as large as 45.7 m (150ft). Of 11 observers that provide data on mound height, six indicate that scrubfowl mounds reach a height of 4.5m. Note that Cayley (1984:101) stated scrubfowl mounds could reach 5 m high, but in a later edition this figure was revised to 4.5 m (Cayley 1991:41). Scrubfowls also build extremely small mounds. Crome and Brown (1979) observed scrubfowls constructing subsidiary mounds, up to 70cm high and 2 m in diameter, which were not used to lay eggs. These small mounds were constructed within 200 m of the active mound and were made of exactly the same materials.

Stone (1989:61) stated that "In my experience, scrub-fowl mounds can vary in height between 0.5 m and 10 m which is the very range recorded by Bailey...for the Weipa mounds. Very large mounds are uncommon..." It is regrettable, given the contrast with all other observers, that Stone provides no details regarding the heights and locations of the very large mounds that he observed. Those he recorded on Channel Island only reached a height of 4 m (Stone 1987:132). The discrepancy between published ethological observations of scrubfowl mounds and Stone's assertions require further explanation. Scrubfowl mounds over 5 m high may be so rare that no observers other than Stone have encountered them. Alternatively, these very large features may have been deposited by humans, as Bailey (1991) argues.

In any case, the distinction that Stone makes between large mounds being scrubfowl mounds and small mounds being human should be abandoned. As Crome and Brown (1979) observed, scrubfowls can produce extremely small mounds (<0.70m), while the data in Table 1 indicate that scrubfowl mounds greater than 5 m high are very rare (if they exist at all). Given the variability in size of bird mounds, height is not a useful distinguishing criterion.

Mound shape. Scrubfowl mounds can take several different forms (Table 1). Apparently the most common form is the conical mound with steeply sloping sides. There is also a rotund, dome-like form with a flattened or hollowed area at the top. Alternatively, fresh material may be added to one side of the mound only, so that the mound eventually becomes a long narrow ridge. The latter may be the form that Gilbert (in Gould 1865:172) referred to when he described mounds adjacent to the water's edge at Port Essington. Gilbert said they were "...irregular in outline, and often resemble a bank thrown up by heavy surf."

Mounds that humans have built or at least contributed to can also take a variety of forms. For example, Roth (1984) described mounds of burnt *Anadara granosa* at the junction of the Hey and Embley rivers near Weipa with the remains of huts and fireplaces on top. These mounds reached over 30 ft in height, and were steep sided: Roth stated that "...these middens can be scaled only with difficulty." By contrast, Roberts (1991:82-84) observed people cooking shellfish on a low, elongated and gently sloping mound at Millingimbi. Shell mounds in other parts of Australia have also taken the form of elongated ridges, with material progressively added to one end only (Connah 1976).

In the light of the variety of forms that scrubfowl mounds and human middens may take, mound shape appears to be an unreliable indicator of whether a mound is of human or avian origin.

Mound composition. Scrubfowl mounds contain a range of material, including earth, stones, compost, leaves, sticks, sand, shells and seaweed (Table 1). As Stone (1989:61; 1991b) noted, composition appears to be dependent upon the materials available in the vicinity of the mound. Mounds adjacent to the beach are composed chiefly of sand, together with either shells, leaf litter or seaweed. Those mounds further inland tend to be composed of soil, compost, leaf litter and sticks. The fact that scrubfowl mounds reflect the immediate environment is not surprising given that scrubfowls obtain material for the mound in the area immediately adjacent to it. Crome and Brown (1979), who observed scrubfowl construction in North Queensland over a period of three years, noted that the scrubfowl obtained material for the mound only within a 25m radius of the mound. Gilbert (in Gould 1865:172) also observed that the scrubfowl only transported material for short distances.

In contrast to scrubfowls, humans can bring material from relatively long distances back to the location where it will be eaten or used (e.g. Meehan 1982). Therefore, mounds constructed by humans may contain material not necessarily found in the immediate area, while scrubfowl mounds must be constructed of materials available in the immediately adjacent area. Of course, if human midden material is present on the ground surface around the mound, this restriction will not necessarily apply. Mound composition relative to the surrounding ground surface therefore forms an important criteria for distinguishing between human and bird mounds. Observations on scrubfowl mounds also suggest that the relative frequency of different components in the mound may serve as a diagnostic criterion.

In some areas Aboriginals have been observed discarding shell on scrubfowl mounds (e.g. Roberts 1991:118-119). However, the observations in Table 1 suggest that scrubfowl mounds usually do not contain marine shell. Only Frith and Hitchcock (1974:129- 130), Mathews and Iredale (1921:219) and Gilbert (in Gould 1865:172) recorded mounds containing shell. Despite the fact that Stone (1989) attributes large and densely packed mounds of shell to scrubfowl, no observer described a scrubfowl creating a mound composed predominantly of shell.

No quantitative data is available on the proportions of shell to other materials within scrubfowl mounds while they are still in use. However, a distinction can be drawn between Gilbert's Port Essington bird mounds and mound features described by archaeologists. Gilbert described those scrubfowl mounds near the beach as "...sandy hillocks..." (Gould 1865:174), and elsewhere as "...sand and shells, without a vestige of any other material, but in some of them I met with a portion of soil and decaying wood..." (Gould 1865:172). These descriptions indicate the presence of considerable amounts of sand and other material in the bird mounds. By contrast, shell mounds recorded archaeologically may be nearly pure shell. For example, the shell mounds of Princess Charlotte Bay "...contain very little interstitial non-shell sediment or other matter." (Beaton 1985:4).

Cribb (1991) made the point that scrubfowls build mounds to incubate their eggs, and that shell does not provide the decaying organic matter needed to do this. He estimated that human mounds in the Aurukun area were composed of a minimum of 80% of shell. By contrast, scrubfowl mounds from the same area could be composed of small amounts of natural or midden shell, together with materials such as sand, soil, vegetable material, and shell grit (Cribb 1991). Cribb suggested that the maximum amount of shell found in such mounds was 5%.

If Cribb has correctly identified the scrubfowl mounds (he doesn't indicate that he saw any of them in use), then the relative frequency of shell appears to be a diagnostic characteristic. The major problem in applying his observation generally is the lack of quantified data. Cribb's figures appear to be estimates only, as no excavations could be undertaken in this area. Does the percentage of shell Cribb refers to represent volume or by weight of sediment? Does the proportion of shell in an abandoned mound change dramatically as the vegetation decays? Does the proportion of shell to sediment vary with depth in the mound, with fine material on the surface being washed or blown away?

In conclusion, mound composition is likely to be diagnostic of origin. Scrubfowl mounds should be composed of materials available in the immediate vicinity of the mound, and will not normally be composed dominantly of shell. However, quantitative data on the proportion of shell in scrubfowl mounds is required before the distinction can be applied with precision. As with any human midden, inedible shell fish species in a human mound should represent less than 1% by volume of shell (Hughes and Sullivan 1974).

Mound environment. As all the observers in Table 1 indicate, scrubfowls build mounds in dense vegetation, usually monsoon vine forest. Areas immediately adjacent to the sea, or along creeks or other waterways are the most favoured locations. Distribution of the mounds reflects the behaviour of the birds. For example, Deignan (1964:361-362) recorded that the scrubfowl was "...restricted to the densest monsoonal forests and mangrove swamps, only occasionally entering the immediately adjacent wattle scrub or venturing onto the naked dunes."

The environmental context of mounds must provide a very clear indication of mound origin. Humanly constructed mounds would not be restricted to monsoon vine forest. Indeed, they would be more likely to be found in other environmental zones, such as floodplains on the edge of mangroves or saltpans (Bailey 1991). As Stone (1991b) points out, however, the distribution of monsoon vine forest has changed throughout the Holocene, and care must be taken to consider palaeoenvironmental data. Both Stocker (1971) and Russel-Smith (1985) have found abandoned scrubfowl mounds in areas no longer covered by monsoon forest. Environmental context is a useful distinguishing criterion, but palaeoenvironmental evidence must be carefully considered.

Mound internal structure. Observations on scrubfowl mounding behaviour show that the mounds are subject to a considerable amount of digging and reworking by the birds. As noted above, burrows up to two metres deep are dug in which to lay the eggs. Further disturbance occurs as the nests are enlarged each breeding season. New material is added to the existing mounds "...by repeatedly excavating holes and filling them in areas where new material had been piled on top of the mound" (Crome and Brown 1979:114). Further, the mounds become consolidated after the heavy rain of the wet season, so that the bird must dig holes in the mound to loosen it (MacGillivray 1914:136; Crome and Brown 1979:114). Accordingly, scrubfowl mounds should lack clearly defined stratigraphic features due to the extensive reworking of deposits.

Archaeologically recorded shell mound deposits tend to contain well defined stratigraphic layers. South Mound at Princess Charlotte Bay contained alternating light and dark coloured layers, with colour reflecting sediment content (Beaton 1985:4). Macassar Well also contained a sequence of light and dark coloured layers (McCarthy and Setzler 1960:Plate 4B). Kwamter mound (Bailey 1975:8) contained numerous lenses of ash and charcoal roughly parallel with the mound's surface.

According to Cribb (1991:24) human shell mounds have an internal structure like a "layer cake". Shell and carbonised material is deposited in human mounds in thin, highly discrete layers, interleaved with layers of sterile sediment. However, Cribb is not referring to his own work, but to that of Bailey (1977) and Beaton (1985). As Stone (1991:27) points out, these sources do not show clear evidence for such distinct and fine layering. Beaton (1985:7) actually stated that "...the fine structure of the mounds is vague in the extreme..."and that he was only able to identify gross structural characteristics while Bailey (1975:8) noted that "One can hardly speak of distinct layers". The lack of perfectly discrete stratigraphic features may be due to disturbance from the activities of crabs and goannas (e.g. Specht 1985; Roberts 1991). In human shell mounds, however, such disturbance would be less severe than in to scrubfowl mounds because disturbance may be minimised in a site with a matrix of large, tightly packed shell fragments (Hughes and Lampert 1977:136-137).

In conclusion, stratigraphic layers with contrasting sediment content are not expected to survive in an active scrubfowl mound due to the extensive reworking. Such features will probably be present in a human shell mound, although they will not necessarily be perfectly discrete.

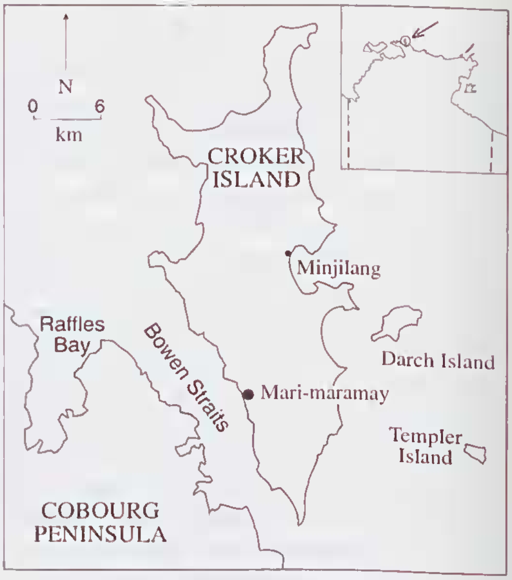

Fig. 1. Location of Mari-maramay.

Contemporary oral history. One other criterion for distinguishing scrubfowl mounds requires discussion: the use of contemporary oral history. Stone (1991b:26) emphasised that "...Aborigines, to my knowledge, have never claimed that their forebears built the large mounds. Indeed, on the few accounts available, Aborigines have always maintained that they were natural features..." This is despite the fact that McCarthy and Setzler (1960:249) were told by a 60 year old Millingimbi Aboriginal "...that these shell mounds were present before he was born and that he had heard that the natives who built them were much more orderly than his people because they gathered up the shells from around the fires and piled them on the mounds."

Little research into Aboriginal beliefs regarding mound origin has been done, and it may well prove to be a profitable avenue of investigation in the future. Nonetheless, conflicting contemporary accounts of mound origin highlight the difficulties of using oral history to interpret archaeological events. Oral history will not necessarily provide a precise method for determining the origins of features that may be thousands of years old.

Summary - characterisitics of human and bird mounds. Qualitative and quantitative differences can be expected between mounds con-

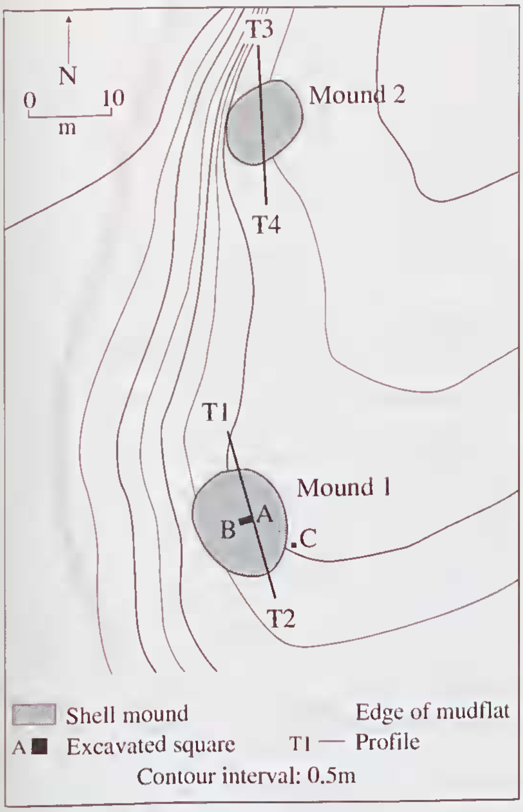

Fig. 2. Plan of Mari-maramay.

structed by scrubfowls, and shell mounds constructed by humans. Composition, internal structure and environmental context of the mounds provide important clues for determining mound origin. By contrast, mound shape and size and contemporary Aboriginal oral accounts do not form reliable indicators of mound origin. In particular, Stone's (1989) argument that the large mounds are not human, and his use of contemporary Aboriginal accounts, are not supported by available data.

Human shell mounds are expected to be composed dominantly of shell. Scrubfowl mounds must be constructed from materials available in the immediate vicinity of the mound, while human mounds are not subject to this restriction. Scrubfowl mounds will not contain distinct lenses or layers of sediment while human mounds probably will. Finally, scrubfowl mounds will be found only in monsoon vine forests, or in areas once covered by monsoon forest. These criteria will now be applied to a recently excavated shell mound from Croker Island, northwestern Arnhem Land.

MARI-MARAMAY: A SHELL MOUND SITE FROM CROKER ISLAND

Mari-maramay is located on the southwest coast of Croker Island (latitude 11°18', longitude 132°32') (Fig. 1). The name "Mari-maramay" is the Aboriginal name for the area (Illijilli Lamilami, pers. comm.). There are two shell mounds at this location. The coastline at Mari-maramay is composed of an extensive mudflat approximately 150 m wide. The mudflat is tidally inundated and contains several stands of mangroves. To the east, behind the mudflat is a gentle laterite slope. Vegetation on the slope consists of open eucalypt woodland. Approximately 100 m to the south of site is a small freshwater creek.

The site is comprised of two discrete, roughly circular mounds of shell (Fig. 2). The two mounds are similar in terms of their size and shape. The larger mound, labelled Mound 1, measures approximately 10 m N-S, and 12 m E-W, and is 1.1 m high. Mound 2 is slightly smaller, at 9 m x 8 m, and 0.8 m high. Both have gently sloping sides (Fig. 3). A similar suite of shellfish species was recorded on the surface of each mound. Both were dominated by the bivalve *Gafrarium tumidum*, together with very small amounts of *Callista planatella, Crassostrea amasa, Anadara granosa, Anadara aliena, Terebralia pelustris* and *Syrinx aruanus*. Shell on the surface of both mounds appeared to be highly weathered and fragmented. No faunal remains, charcoal or artefacts were observed on the surface of either mound.

The larger of the two mounds, Mound 1, was chosen for excavation. Two adjacent 0.5 m x 0.5 m pits (Squares A and B) were excavated in the centre of this mound (Fig. 3). A 0.4 m x 0.3 m sondage (Square C) was also excavated one meter from the base of the mound on the eastern margin of the mound (Fig. 2). Excavation proceeded by the Johnson (1979:151) bucket technique. Removal of each excavation unit continued until a 10 litre bucket had been filled with sediment or a change in sediment colour and/or texture was observed. Sediment was weighed and then sieved through 6 mm and 3 mm mesh nested sieves. The entire remains of each fraction were retained, together with a bulk sample from every third excavation unit. The pH level and Munsell colour were recorded for each spit.

STRATIGRAPHY AND CHRONOLOGY

During excavation of Squares A and B, two major strata were identified. These were the shell layers comprising the mound itself (Strata I), and the layers of laterite and clay on which the mound rests (Strata II) (Fig. 4). The major difference between the two strata was the density of shell, with Strata I composed mostly of shell, and Strata II containing virtually no shell at all.

As well as dense concentrations of shell, the layers within Strata I contained a matrix of fine dark grey or brown silt. Stone artefacts, vertebrate material, and charcoal also occurred within this strata, together with pieces of sandstone and ferricrete. Five discrete layers within Strata I were distinguished during excavation, primarily on the basis of the colour of the matrix. Other distinguishing criteria included the degree of weathering on the shells, and the degree to which the sediment was compacted. Strata II, by comparison, contained very little shell, and was composed mostly of red/brown laterite pebbles and clay. No stone artefacts, charcoal, vertebrate material, or sandstone were found in this strata.

Five different layers were identified in Strata I, and two layers in Strata II:

IA *Surface Shell Layer.* The surface of the mound was composed almost entirely of loose shell, together with a relatively small amount of finer sediment. The shell in this layer was highly weathered and fragmented.

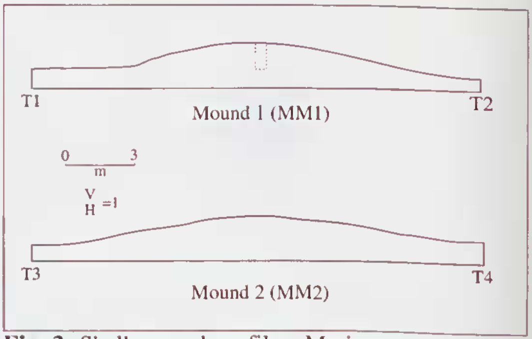

Fig. 3. Shell mound profiles, Mari-maramay.

IB *Dark Brown Shell Layer.* A very compact layer of unweathered shell with a matrix of fine, dark brown (10YR 2/1) silt. Small pieces of charcoal are scattered throughout this layer.

IC *Charcoal Rich Shell Layer.* A layer of unweathered shell with mottled light grey/ dark brown (10YR 4/1) silt and sand. The texture of this layer was rather loose and friable, particularly towards the base. The sediment also gradually became lighter in colour towards the base of this layer. This layer contained two lenses of charcoal. The largest measured >0.35 m across and was 0.02-0.03 m thick. A second lens of charcoal, visible in the north wall of Square A (Fig. 4) measured 0.25 m across and was 0.02-

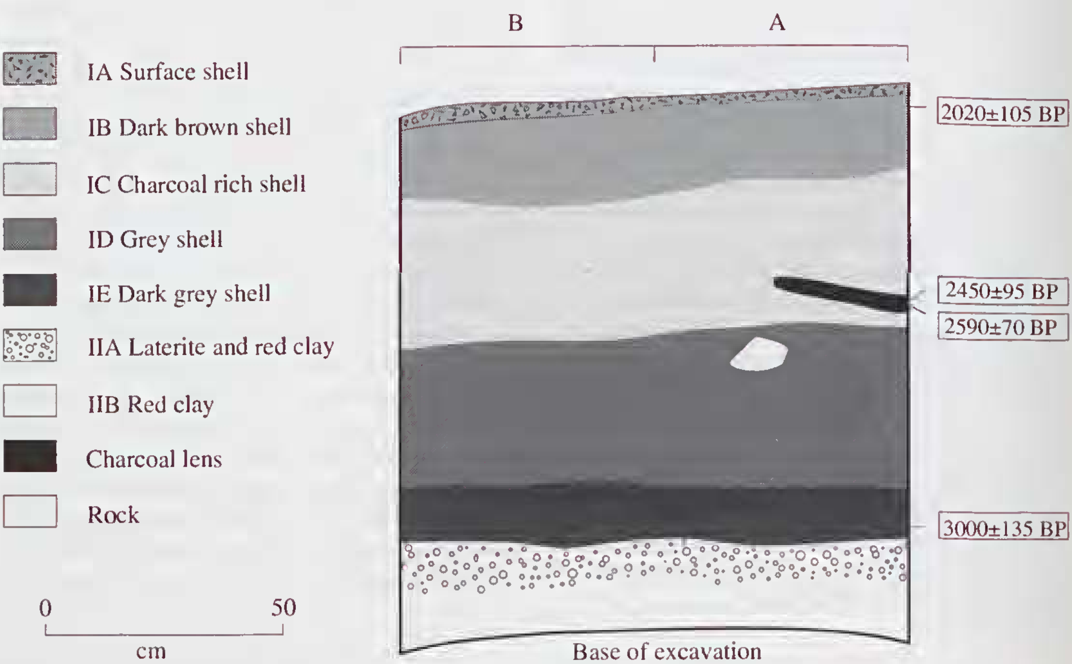

Fig. 4. Stratigraphic profile, North Wall, Mound One, Mari-maramay.

0.03 m thick. Although isolated pieces of charcoal were present throughout the layer, the lenses were discrete stratigraphic features.

ID *Grey Shell Layer.* A layer of unweathered shell and grey (10YR 3/1) silt. The shell was relatively loose and friable at the top, becoming more compact towards the base. The layer contained some small fragments of charcoal.

IE *Dark Grey Shell Layer.* A compact layer of fine, dark grey (10YR 3/2) silt with a high frequency of unweathered shell. Small pieces of charcoal were scattered throughout. The sediment at the base of this layer was tinged with a red/brown sediment, probably originating from the unit below. A small, discrete lens of charcoal was uncovered at the top of this layer in Square A.

IIA *Laterite Layer.* A layer of fine brown (7.5YR 3/3) silt with large quantities of ferricrete and laterite pebbles. This layer contained very little shell and charcoal compared to overlying layers. This layer appeared to be the original surface on which the mound was formed.

IIB *Red Clay Layer.* A very compact layer of red/brown (5YR 3/3-4/6) clay with some ferricrete and laterite pebbles. This layer contained no charcoal or shell.

A small sondage (Square C), 0.4 m x 0.35 m wide and 0.35 m deep, was dug 1 m from the eastern margin of Mound 1 (Fig. 2). The purpose of this excavation was to compare sediments on the ground surface to the stratigraphic layers immediately below the shell mound (Strata II). No shell was present on the ground surface at this location. Two stratigraphic layers were revealed during excavation of the sondage. The top layer was a layer of light grey/brown (10YR 5/2) silt with ferricrete rocks and laterite pebbles. No shell was present in this layer. This layer was 0.10 m deep, and was similar in texture to Layer IIA from the excavation. The basal layer, which extended to the base of the sondage, was comprised of an orange/brown clay (10YR 5/4). There was no rock, shell or charcoal in this layer, and it appears to be the equivalent of layer IIB in the excavation. The results of this sondage confirmed that Strata II from Square A represents the old laterite ground surface on which the mound was constructed.

Four radiocarbon dates have been obtained from Square A, and these are presented in Table 2. Three dates were on marine shell, and one was on charcoal from the charcoal lens in Layer IC. A marine oceanic reservoir correction factor of 450±35 B.P. has been deducted from the shell dates to make them compatible with the charcoal date (after Polach *et al.* 1983; Rhodes *et al.* 1980; Bowman 1985). The radiocarbon dates suggest deposition of the site began at approximately 3000 B.P.. and continued until approximately 2000 B.P. Sedimentation appears to have been relatively gradual throughout this period. No stratigraphic features consistent with a depositional hiatus, (e.g. an unexposed layer of highly weathered shell) were observed during excavation.

Table 2. Radiocarbon Dates from Square A, MM1.

Spit	Depth (cm)	Material	Lab.No. (Beta)	Date	Corrected Date
2	2.5	Shell	44835	2470±70	2020±105
13	50	Charcoal	47222	2590±70	2590±70
13	50	Shell	47223	2900±60	2450±95
22	91	Shell	44836	3450±80	3000±135

LABORATORY METHODS

All sieve residues were washed and dried. The different components; shell, charcoal, rock and vertebrate faunal remains, were seperated out and weighed. In order to calculate the percentage of shell in the sediments <3mm^2 in size, macroscopic particles of shell were sorted by hand from a number of bulk sediment samples. Removal of calcium carbonate through dissolution in acid (Hughes 1983:114-115) would not be appropriate in this case. This method would not distinguish between shell fragments and the fine carbonaceous sediments which are a ubiquitous feature of coastlines on Croker Island (Day and Forster 1975).

Shell species were identified on the basis of comparative collections housed in the Northern Territory Museum. Photographs from Blackburn (1982), Meehan (1982) and Wells and Bryce (1988) were also used. Minimum number of individuals (MNI) was calculated for each shell species. MNI of gastropods was calculated by counting the number of body whorls. For each species of bivalve, except oysters, shells or shell fragments with left or right hinges were counted. MNI was taken as the larger number out of the left or right hinges. Diagnostic elements employed for oysters were left valves (or "lids") with more than half the adductor muscle scar visible, and whole umbos of the right convex valve (after Nolan 1986:50).

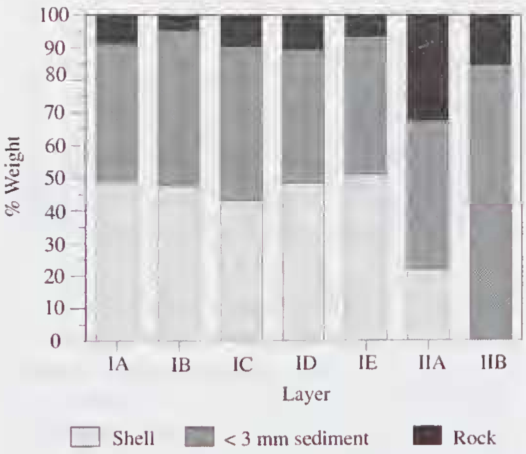

Fig. 5. Components of excavated sediments, Square A, Mound 1, Mari-maramay.

SHELL

Sieve residues and bulk samples were analysed to determine the proportion of marine shell within the sediments from Strata I. Shell retained in the sieves comprised approximately 50% by weight of all excavated sediment from Strata I (Fig. 5). The percentage of shell by weight in the excavated sediments drops from just over 20% in Layer IIA, to zero in Layer IIB (Fig. 5). Sediments not retained in the sieves (i.e. <3mm^2 in size) formed a significant component of sediments excavated in all stratigraphic layers. Of the five bulk sediment samples analysed from Strata I, shell comprised on average 17.2% by weight. This result indicates that the total shell content of sediments from Strata I varies between approximately 60% and 65% by weight. Marine shell is therefore the dominant component within the mound.

The shell species identified in Square A are listed (in descending order of frequency) in Table 3. As can be seen, *Gafrarium tumidum* represents over two thirds of the shellfish in Square A. *Callista planatella* is the next most common species at 24.3%, and oyster (*Crassostrea amasa*) represented 3.5% of the shellfish. Other species of shellfish were present in frequencies of less than 1.5%. Of the species represented, only three are not considered edible by humans. The Chitonidae and Cerithidae species are too small to be edible, while *Strombus* sp. is amongst those species listed as not eaten by the Gidgingali by Meehan (1982:181). These three species together represent approximately 1.6% by MNI of the total shells in the midden. All other species have either been identified to the author by Cobourg Peninsula Aboriginals as edible, and/or were listed in Meehan's (1982:179-181) list of species eaten by the Gidgingali. Given that the inedible species are quite small, edible shellfish must represent well over 99% by volume of the shells within the mound, satisfying Hughes and Sullivan's (1974) criterion for a human shell midden.

MATERIAL OTHER THAN SHELL

Sieve residues from Mound 1 contained various components other than marine shell. These included stone artefacts, unaltered stone, and vertebrate and invertebrate material. Although marine shell comprised the dominant faunal remains in the mound, small quantities of fish and mammal bone, and crab carapace, were recovered from Layers IB, IC, and ID. The fish remains included several otoliths (possibly *Lutjanus* sp.).

Reflecting a general scarcity of siliceous stone in the Cobourg Peninsula area, few stone artefacts were found during the excavation. Two stone artefacts were recovered from Square A, while a third artefact, a core, was found on the surface of Mound 1. A ferricrete flake was recovered from Spit 12, Square A, with a length

Table 3. Shell species identified in Square A.

Species	MNI	% MNI
Gafrarium tumidum	10150	67.5
Callista planatella	3667	24.3
Crassostrea amasa	525	3.5
Cerithidae*	201	1.3
Nerita chameleon	134	0.9
Terebralia pelustris	125	0.8
Atactrodea striata	50	0.3
Chitonidae*	33	0.2
Anadara granosa	31	0.2
Telescopium telescopium	31	0.2
Turbo cinerus	25	0.2
Nerita polita	22	0.
Anadara aliena	17	0.1
Asaphis deflorata	11	<0.1
Pinctada maxima	7	<0.1
Volegelea wardiana	5	<0.1
Syrinx aurianus	3	<0.1
Polymesoda coaxans	3	<0.1
Circes cripta	2	<0.1
Strombus sp.	2	<0.1
TOTAL	**15046**	**100**

* Non-edible species

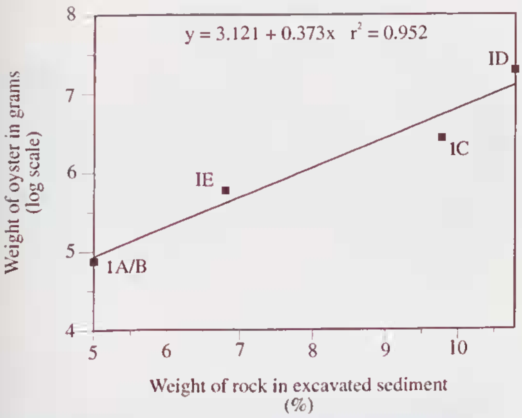

Fig. 6. Correlation between weight of oysters and weight of rock, by layer, Square A, Mound 1, Mari-maramay.

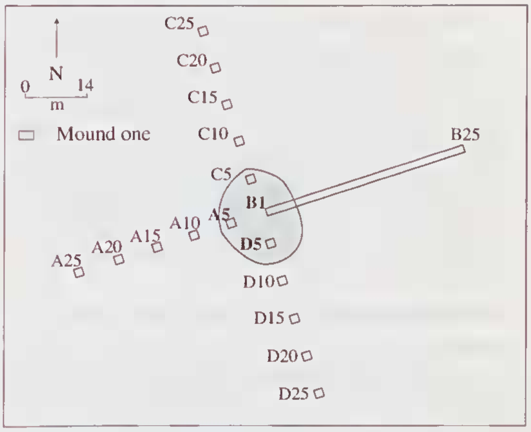

Fig. 7. Transect units, Mound One, Mari-maramay.

of 10mm and width of 12mm. A quartz flake was also found in Spit 19, which measured 9mm long and 5mm wide. The core was made of ferricrete, and measured 95x60x12mm. In all three cases, the stone used to manufacture the artefacts appeared to be of poor quality for knapping.

Rock that showed no evidence of alteration by humans was present in every stratigraphic unit. It included small laterite pebbles, as well as pieces of sandstone and ferricrete. Many of the rocks had the right hinges of oysters still attached to them. There was a very high correlation (r^2=0.952) between the weight of oysters and the weight of rock within each stratigraphic unit (Fig. 6). Note that for Figure 6, Layer IA was combined with Layer IB due to the small sample size of the former. This correlation indicates that rocks have been introduced to the mound together with oysters, an observation that will be considered further in the following discussion of mound origins.

IS MM1 A HUMAN MOUND?

As discussed above, the following criteria are considered relevant in distinguishing between scrubfowl and human mounds: mound content, mound structure and environmental context.

Mound content. As noted above, shell represented approximately 60-65% by weight of all sediments excavated from Strata 1. Shell is therefore the major component of the mound, an observation consistent with a human origin. The high percentage (>99% by volume) of edible species within the mound is also consistent with a human origin.

In order to assess whether the material in the mound could have been scraped up from the surrounding area, transects were run across MM1 and surrounding ground surface (Fig. 7). The MNI of shells in each square was recorded. The intention of this process was to be able to compare the mound contents to the contents of the ground surface. If the mound was scraped up from the surrounding soil, then the characteristics of these two data sets should be very similar. The data set showed distinct differences in the density of shell on and off the mound. *There was no marine shell at all on the ground surface around the mound.* Shell only occurs within the mound itself. The MNI/m^2 of shell on the surface of the shell mound ranged from 42 to 147 ($\bar{x}$=103.9, n=8). The lack of subsurface shell on the margin of the mound was confirmed by the results of the sondage. Since it seems unlikely that a bird would scrape up every single piece of shell, I conclude that the shell in the mound was derived from another location. This conclusion also indicates the mound is human in origin.

The other difference between the mound and the ground surface is in the nature of the rocks. Rocks were present in all of the sampled squares on the mound and in some of the areas around the mound. Rocks in the mound were often found attached to oyster valves, and as mentioned above, there was an extremely high correlation between number of oysters and the weight of rock. None of the rocks on the ground surface around the mound was observed to have oysters attached. This suggests the rocks in the mound were not scraped up from the immediate vicinity of the site. Instead, rocks were added to the mound by humans bringing oysters onto the mound.

Internal structure. Three discrete, horizontally banded lenses of charcoal were uncovered during excavation. Two were present in Layer IC, and one in Layer IE. The lenses were up to 0.35 m across, and 0.03 m thick. In a scrubfowl mound, such features would not survive as discrete entities due to the extensive digging and reworking of deposits by the birds. The internal structure of Mound 1 accordingly suggests that it is human in origin.

Environmental context. As noted above, the mounds are not presently located in vine forest, but in open schlerophyll forest. There are small patches of monsoon vine forest on Croker Island (Day and Forster 1975), the closest of which is 4.5km away. Monsoon vine forest may have been more extensive in the past. However, the mound was formed during during a period of decreased wet season precipitation that occurred between 2800 and 1600 B.P. (Lees and Clements 1987; Lees *et al.* 1990). Monsoon vine forest would have been more restricted, not more extensive, at this time. Environmental context therefore strongly suggests MM1 is of human origin.

CONCLUSION

Observations on scrubfowl nesting behaviour suggest substantial differences can be identified between human shell mounds and scrubfowl mounds. Distinctions drawn on the basis of mound height should be abandoned. Given the small amount of research into Aboriginal perceptions of mound origin that has been completed, the use of contemporary Aboriginal accounts must also be questioned. Nonetheless, mound composition, internal structure and environmental context can provide useful criteria. These characteristics were employed to confirm the human origins of a shell mound at Croker Island.

Shell mounds have long been a focus of archaeological research along the coastline of northern Australia (e.g. Warner 1932). If these features are of natural origin, many of our models of north Australian coastal settlement and subsistence patterns (e.g. Beaton 1985; Meehan 1982; Peterson 1973) must be abandoned. I contend that the first step is the gathering of field data on mounds with the question of origin in mind, and the further testing and refinement of models concerning mound formation.

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